Identifying subtypes of dual alcohol and marijuana users: A methodological approach using cluster analysis

Magdalena Harrington, MA[1], **Janette Baird, PhD**[2,3], **Christina Lee, PhD**[4,6], **Ted Nirenberg, PhD**[2,3,5], **Richard Longabaugh, EdD**[4,5], **Michael J. Mello, MD, MPH**[2,3,7], and **Robert Woolard, MD**[8]

[1]Department of Psychology, University of Rhode Island, Kingston RI

[2]Injury Prevention Center at Rhode Island Hospital Providence, RI

[3]Department of Emergency Medicine, Alpert School of Medicine of Brown University, Providence, RI

[4]Center for Alcohol and Addiction Studies, Brown University, Providence RI

[5]Department of Psychiatry and Human Behavior, Alpert School of Medicine of Brown University

[6]Institute on Urban Health Research, Northeastern University, Boston MA

[7]Department of Community Health, Alpert School of Medicine of Brown University, Providence, RI

[8]Department of Emergency Medicine, Paul Foster School of Medicine, Texas Tech University Health Sciences Center, El Paso, Texas

Abstract

Alcohol is the most common psychoactive substance used with marijuana. However, little is known about the potential impact of different levels of use of both alcohol and marijuana and their influence on risky behaviors, injuries and psychosocial functioning. A systematic approach to identifying patterns of alcohol and marijuana use associated with increased risks has not yet been identified in the literature.

We report on the secondary analysis of data collected from a RCT conducted in a busy urban emergency department. Cluster analysis was performed on the patterns of past 30-day alcohol and marijuana use in two random subsamples $N_1 = 210$ and $N_2 = 217$. Four distinct subtypes of those who use both alcohol and marijuana were identified: (1) Daily Marijuana and Weekly Alcohol users; (2) Weekly Alcohol and Weekly Marijuana users; (3) Daily Alcohol and Daily Marijuana users; and (4) Daily Alcohol, Weekly Marijuana users. The four subtypes were replicated in both

subsamples and examination of the external validity using ANOVA to determine cluster differences on psychosocial and behavioral variables confirmed the theoretical relevance of different patterns of alcohol and marijuana use. There were significantly different psychosocial negative consequences and related risky behaviors among subtypes.

We found that Daily Alcohol and Daily Marijuana users are at the highest risk to experience more negative consequences and engage in a broader spectrum of risky behaviors related to both substances, than the other three types of alcohol and marijuana users.

Keywords

Alcohol; Marijuana; Cluster analysis

1. Introduction

Alcohol is used more often with marijuana than any other illicit drug (Degenhardt et al., 2001). Alcohol and marijuana have the highest rates of dependence or abuse as a primary substance, and the highest rate of treatment admissions for drug dependency or abuse (SAMHSA, 2009). Despite the high prevalence of dual alcohol and marijuana use, the typology of dual alcohol and marijuana users has not been adequately examined, and it is unknown whether this population is highly heterogeneous, as are populations of other substance users.

Cluster analysis is an empirical approach to identifying homogenous groups with distinctive characteristics within a heterogeneous population. This is an exploratory technique that consists of a number of consecutive steps, from which the most reliable cluster solution is generated. This procedure consists of identifying cases, variable selection, determining distance metric, choosing a hierarchical algorithm, deciding on the number of clusters, cluster interpretation, and the internal and external validation of clusters (Rapkin & Luke, 1993). This method has been widely applied in community and health psychology research (Babor et al., 1992; Humphreys & Rosenheck, 1995; Velicer et al., 1995; Maibach et al., 1996; Norman & Velicer, 2003; Shaw et al., 2008).

In the current study, we propose to 1) establish the type of association between alcohol and marijuana use, hypothesizing that there is multidimensional relationship between these two substances; 2) identify distinct patterns of dual alcohol and marijuana use; and 3) examine differences in the negative consequences among different patterns of dual substance use.

2. Method

This study is a secondary analysis of randomized control trial testing a brief intervention at an academic, urban trauma center emergency department (ED). Eligible patients (N = 515) were 18 years and older, English speaking and agreed to participate in a research study that examined the effects of two sessions of Motivational Interviewing (MI) on risk behavior reduction among alcohol and marijuana users (Woolard et al., 2009). The present study included participants who reported both alcohol and marijuana use in the prior 30 days (N = 427).

2.1. Measures

Alcohol, Marijuana and Drug Use Index (AMD) consists of seven items referring to the frequency of alcohol, marijuana and other drug use in the prior 30 days (Nirenberg, Lee et al., 2003).

Alcohol Use Disorders Inventory Test (AUDIT) is a ten-item measure of self-reported frequency of alcohol use, binge drinking episodes (defined as six or more drinks containing alcohol on a single occasion) and alcohol related negative consequences in the prior 12 months (Saunders et al., 1993).

Marijuana Problem Scale (MPS) is a nineteen-item measure that assesses the problems related to the use of marijuana in the areas of negative psychological, social, occupational, and legal consequences (Stephens, Roffman, & Curtin, 2000).

Noteworthy Index of Problem (NIP) was developed and adapted from the Drinkers Inventory of Consequences (Longabaugh et al., 2001). This instrument examines the frequency of 19 psychosocial events related to alcohol and/or marijuana use in the past three months.

Injury Behavior Checklist (IBC) consists of self reported responses to seventeen questions regarding different types of injuries in the 12 months preceding the ED visit (not including the injury that brought participant to the ED) (Longabaugh et al., 2001).

High Risk Behavior Scale (HRB) is a 12 item scale that uses questions from the Household Behavior Survey concerning seatbelt use and drinking and driving questions. We asked additional questions about the participants' frequency of other high risk behaviors such as driving after binge drinking, and driving after use of marijuana.

2.2. Analyses

Statistical analyses were conducted using SAS (Version 9.1.3; Carey, NC.). Cluster analysis was performed in a series of steps, described below.

2.2.1. Variable and participant selection—To determine typology of alcohol and marijuana users, two items examining frequency of alcohol and marijuana use from the AMD instrument were chosen: 1) "In the past 30 days how many days you used alcohol?" and 2) "In the past 30 days how many days you used marijuana?" Pearson's correlation coefficient between the two variables was examined to assure the condition of independence of variables. Cluster profiles based on highly correlated measures tend to be repetitive and have less distinctive shapes (Rapkin and Luke, 1993). The frequency of alcohol and marijuana use were standardized and transformed to T – scores (Mean = 50, SD =10) to eliminate unintentional weighting of one of the variables (Velicer, 2007). The sample of 427 participants was randomly divided into two sub-samples of N_1 = 217 and N_2 = 210. Cluster analysis was performed independently on both groups to allow cluster replication and comparison.

2.2.2. Distance metric *and* hierarchical algorithm—To develop initial cluster subtypes, squared Euclidean distance measure and agglomerative hierarchical clustering method with Ward's algorithm were used to develop the initial cluster subtypes (Milligan, 1980; Milligan & Cooper, 1987). Cubic clustering criterion, pseudo F test and pseudo t2 test (Aldenderfer & Blashfield, 1984; Milligan & Cooper, 1985) were used to determine the number of cluster solutions.

2.2.3 Validity—To examine the internal validity of typology of alcohol and marijuana users, cluster analysis was performed independently on both sub-samples and then results were compared based on statistical indices and visual representation. The data from both samples were merged based on the cluster membership and then used for external validity analysis. To demonstrate discriminant validity among different patterns of alcohol and marijuana use, a set of variables, not included in the cluster analysis, but theoretically

relevant to clustering variables were used. Analysis of variance (ANOVA) was used to examine cluster differences on psychosocial (AUDIT, MPS, and NIP) and behavioral (HRB and IBC) variables.

3. Results

3.1. Choosing the number of clusters

Pearson's correlation coefficient between frequency of alcohol and marijuana use was small at r = .11, which confirms that the variables are independent and both contribute to the cluster analysis. To determine the optimal cluster solution, the cubic clustering criterion, pseudo F test, and pseudo t^2 test stopping rules were examined (Milligan & Cooper, 1985). Based on these criteria, the four cluster solution appeared to be the most appropriate. Next, visual analysis of the profiles along with their level, scatter and shape were examined (Velicer, 2007).

3.2. Internal validation

The process of determining the number of clusters was replicated independently in the two sub-samples. Four distinct patterns of alcohol and marijuana use were identified in both sub-samples.

3.3. Cluster profiles

The following cluster profiles were identified. We report on the mean number of days of substance use in the 30 day period for each cluster. Cluster 1 (N = 93): *Daily Marijuana and Weekly Alcohol users;* this profile characterizes individuals who reported on average daily or almost daily marijuana use (M = 29.35, SD =1.36) and alcohol use once to twice a week (M = 4.78, SD = 3.45). Cluster 2 (N = 223): *Weekly Alcohol and Weekly Marijuana users;* this profile characterizes individuals who reported on average once to twice a week of alcohol (M = 5.28, SD = 3.63) and marijuana (M = 7.27, SD = 6.41) use. Cluster 3 (N = 56): *Daily Alcohol and Daily Marijuana users;* this profile characterizes individuals who reported on average daily or almost daily use of alcohol (M = 20.82, SD = 5.10) and marijuana (M = 26.66, SD = 4.34). Cluster 4 (N = 55): *Daily Alcohol, Weekly Marijuana use*rs; this profile characterizes individuals who reported on average daily or almost daily alcohol use (M =21.05, SD =6.05) and once to twice a week of marijuana use (M = 5.20, SD = 4.06). The graphical illustration of the four profiles is presented in Figure 1. There were no significant differences among the four clusters on age, race, ethnicity and education. There were significant differences between males and females ($\chi^2(3)$ = 13.62, p < .05), indicating that more females (65.38%) than males (46.46%) were characterized by the Weekly Alcohol and Weekly Marijuana use cluster.

3.4. Validity of Clusters

One-way analysis of variance was performed to assess external validity of the proposed typology of alcohol and marijuana users, and to examine differences among clusters on psychosocial and behavioral measures. Significant differences, with effect sizes ranging from small (η^2 = .02) to large (η^2 = .22), were found for AUDIT, MPS, IBC, NIP and HRB items (Table 1).

Using a post hoc Tukey test to examine patterns of means for four clusters, significant differences among the clusters were found. Individuals who used alcohol daily in two separate clusters (Daily Alcohol and Daily Marijuana use and Daily Alcohol and Weekly Marijuana use) had significantly greater levels of AUDIT, experienced significantly more alcohol and alcohol and marijuana related negative psychosocial events and significantly

higher frequency of driving under the influence of alcohol as well as after a heavy episode of drinking than people in clusters characterized by weekly and not daily alcohol use.

Individuals who used marijuana daily in two separate clusters (Daily Marijuana and Weekly Alcohol and Daily Alcohol and Daily Marijuana) reported significantly more injuries and negative psychosocial events related to marijuana, as well as incidents of driving under the influence of marijuana, than people who reported weekly and not daily marijuana use.

Finally, individuals in the Daily Alcohol and Daily Marijuana use cluster reported significantly more incidents of driving under the influence of both substances, more marijuana related problems, the highest number of injuries and engaging in significantly more physical fights than any other cluster. Detailed results of cluster group comparisons on psychosocial and behavioral measures are presented in Table 1.

4. Discussion

Overarching study goals were to examine a typology of dual alcohol and marijuana users among the population of adult ED patients, and to examine differences in negative consequences associated with these different patterns of use.

Each cluster of dual use was associated with different patterns of risky behaviors and negative psychosocial consequences. Daily Alcohol and Daily Marijuana users were at highest risk of experiencing negative consequences and of engaging in a broader spectrum of risky behaviors related to both substances than the other three types of alcohol and marijuana users. Results suggest that daily or almost daily use of alcohol and marijuana together places individuals at the highest risk of injuries and negative psychosocial consequences, followed by daily use of either alcohol or marijuana in conjunction with weekly use of the other substance. Weekly use of alcohol and marijuana placed individuals at the lowest risk for injuries and negative psychosocial consequences.

Distinct clinical presentation of each of the four clusters has significant implications for treatment and can provide guidance for the development of more effective interventions that will target both substances and unique challenges related to each substance simultaneously.

4.1. Limitations

This study has limitations. First, our analytical approach requires replication of the findings prior to more extensive generalization of the results. Second, given the methodological problems of quantifying marijuana use, only the frequency of alcohol and marijuana was used as a metric to identify the four clusters rather than the quantity.

4.2. Conclusions

In these analyses our intention was to demonstrate that there are subgroups of alcohol and marijuana users that have both theoretical and potential clinical relevance. It has yet to be established if these clusters would replicate in a more general population of dual substance users, or to determine if the subtypes of users responded differentially to the brief intervention received in the original study. However, these clusters do offer a more sensitive means of identifying how people use these substances and identify potential areas for interventions around the specific typologies of use

Research Highlights

- Alcohol is the most common psychoactive substance used with marijuana

- Dual use is more risky than use of either alcohol or marijuana alone

- Cluster analysis is an empirical method to establish subtypes of substance users

- Four distinct subtypes of alcohol and marijuana users were determined

- Recognizing subtypes of conjoint users may increase effectiveness of tailored interventions.

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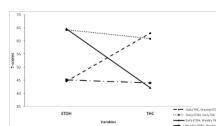
Figure 1.
Four cluster profiles

Table 1

One-way analysis of variance by four clusters and AUDIT, MPS, IBC, NIP and HRB scales

	Cluster 1 Daily THC, Weekly ETOH	Cluster 2 Weekly ETOH, Weekly THC	Cluster 3 Daily ETOH, Daily THC	Cluster 4 Daily ETOH, Weekly THC	Test Statistics F	Effect size η^2	Post Hoc Tukey Test
AUDIT							
M (SD)	10.44 (6.08)	11.48 (6.82)	11.48 (6.82)	19.78 (9.34)	$F(3, 420) = 39.92$ ***	0.22	3, 4 > 1, 2 ***
MPS [?]							
M (SD)	2.25 (1.26)	1.90 (1.21)	2.65 (1.18)	2.01 (1.49)	$F(3,417) = 6.01$ ***	0.04	3 > 4 *, 2 **
IBC [?]							
Any injuries							
M (SD)	1.99 (2.43)	1.76 (1.40)	3.30 (3.48)	2.30 (3.46)	$F(3,423) = 6.77$ ***	0.05	3 > 1 **, 2 ***
Alcohol related injuries							
M (SD)	0.10 (0.33)	0.38 (0.72)	0.48 (0.70)	0.62 (0.82)	$F(3,423) = 8.22$ ***	0.06	1 < 2, 3 **, 4 ***
Marijuana related injuries							
M (SD)	0.73 (1.35)	0.22 (0.50)	0.51 (0.71)	0.02 (0.13)	$F(3,423) = 13.74$ ***	0.09	1 > 2, 4 ***
NIP [?]							
Alcohol and marijuana related events							
M (SD)	2.02 (1.76)	1.72 (1.71)	3.14 (1.90)	2.67 (2.18)	$F(3,410) = 10.63$ ***	0.07	3 > 1 **, 2 *** 4 > 2 **
Alcohol related events							
M (SD)	2.08 (1.68)	2.30 (1.60)	3.33 (1.87)	3.83 (1.86)	$F(3, 410) = 17.80$ ***	0.12	3, 4 > 1, 2 ***
Marijuana related events							
M (SD)	2.23 (1.57)	1.45 (1.44)	2.33 (1.79)	1.64 (1.61)	$F(3, 410) = 8.24$ ***	0.06	1 > 2 ***
HRB							
During the past 30 days how many times did you drive when you had too much to drink?							
M (SD)	0.21 (0.64)	0.30 (1.01)	2.25 (4.74)	1.96 (4.79)	$F(3, 423) = 14.30$ ***	0.09	3 > 1, 2 *** 4 > 1, 2 **
During the past 3 months how many times did you drive within 2 hours of using both alcohol and marijuana?							
M (SD)	1.65 (4.21)	0.92 (2.21)	9.59 (17.56)	1.98 (4.00)	$F(3,422) = 23.59$ ***	0.14	3 > 1, 2,4 ***
During the past 3 months how many times did you drive within 2 hours of using alcohol only?							
M (SD)	1.12 (5.53)	1.23 (2.99)	5.13 (11.24)	7.53 (15.85)	$F(3, 421) =12.85$ ***	0.08	3 > 1 *, 2 ** 4 > 1,2 ***

	Cluster 1 Daily THC, Weekly ETOH	Cluster 2 Weekly ETOH, Weekly THC	Cluster 3 Daily ETOH, Daily THC	Cluster 4 Daily ETOH, Weekly THC	Test Statistics F	Effect size η^2	Post Hoc Tukey Test
During the past 3 months how many times did you drive within 2 hours of using marijuana only?							
M (SD)	29.91 (39.07)	3.87 (10.17)	31.14 (38.43)	1.57 (2.81)	$F_{(3,421)} = 40.56$***	0.22	1, 3 > 2, 4***
During the past 3 months how many times did you drive after having 5 or more (males)/ 4 or more (females) drinks?							
M (SD)	0.43 (1.81)	0.82 (2.78)	6.64 (11.56)	4.51 (10.07)	$F_{(3, 423)} = 19.88$***	0.12	3 > 1, 2*** 4 > 1, 2**
During the past 3 months how many times have yoou been involved in a physical fight?							
M (SD)	0.71 (1.55)	0.51 (1.61)	2.63 (7.59)	0.69 (2.16)	$F_{(3, 423)} = 6.87$***	0.05	3 > 1**, 2***, 4***
During the past 3 months how many times have you been involved in a physical fight within 2 hours of using both alcohol and marijuana?							
M (SD)	0.83 (1.09)	0.42 (0.65)	2.48 (3.53)	0.73 (1.16)	$F_{(3, 125)} = 8.32$***	0.17	3 > 4*, 1**, 2***
During the past 3 months how many times have you been involved in a physical fight within 2 hours of using alcohol only?							
M (SD)	0.40 (1.83)	0.70 (1.11)	1.33 (3.12)	2.07 (3.81)	$F_{(3, 125)} = 2.35$	0.05	
During the past 3 months how many times have you been involved in a physical fight within 2 hours of using marijuana only?							
M (SD)	0.57 (0.86)	0.14 (0.40)	1.41 (4.37)	0	$F_{(3, 125)} = 2.65$	0.06	
During the past 3 months how many times have you been involved in Motor Vehicle Crash (MVC)?							
M (SD)	0.15 (0.44)	0.13 (0.46)	0.07 (0.26)	0.07 (0.26)	$F_{(3, 423)} = 0.79$	0.006	
During the past 3 months how many times have you been a passenger when driver was under the influence of alcohol?							
M (SD)	4.97 (12.77)	2.88 (8.82)	6.64 (14.96)	7.69 (17.65)	$F_{(3, 423)} = 3.26$*	0.02	4 > 2*
During the past 3 months how many times have you got a moving traffic violation?							
M (SD)	0.29 (0.85)	0.08 (0.30)	0.16 (0.63)	0.20 (0.45)	$F_{(3, 423)} = 3.77$*	0.03	1 > 2**
During the past 3 months how many times have you speed over 10 mph over the limit?							
M (SD)	38.02 (99.10)	23.45 (38.46)	47.41 (59.50)	25.38 (36.36)	$F_{(3, 422)} = 3.16$*	0.02	3 > 2*

*
  $p < .05$

**
  $p < .01$

***
  $p < .001$

[?] square root transformed score